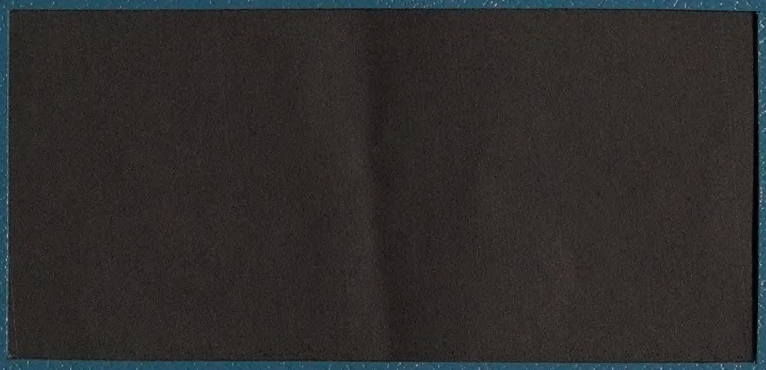

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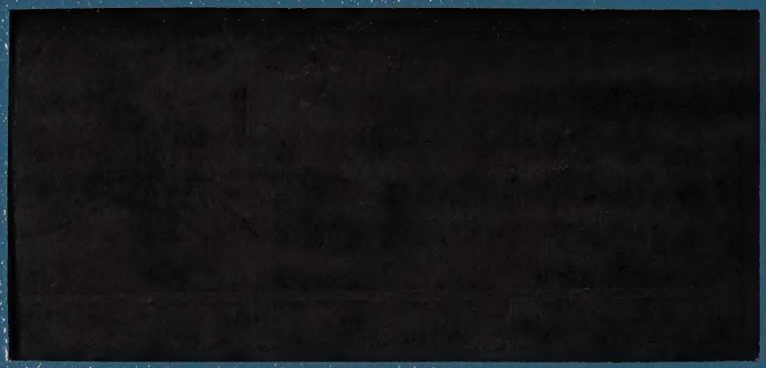

INSTRUCTION/MAINTENANCE MANUAL

ITHACO MODEL 99511

20 CHANNEL BUFFER AMPLIFIER

OCTOBER 1990

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SECTION 1

SPECIFICATIONS

1.1 GENERAL DESCRIPTION:

The amplifier chassis contains 20 differential input/single ended output channels. Its purpose is to provide high impedance buffering for radio receiver output signals being routed to an array of recording and test equipment. It is designed to withstand vibration encountered on shipboard and airborne environments during long periods of deployment.

The chassis contains four digital channels on one quad channel plug–in module and sixteen analog channels on eight dual channel plug–in modules. The chassis also includes a built–in (non–modular) ac line powered dc supply for all modules. Control switches are on the front panels of the modules. I/O connections are on the rear panel of the chassis.

99511A:	Dual Analog Amplifier Module
99511B:	Quad Digital Amplifier Module
99511C:	Chassis with Integral Power Supply

1.2 MECHANICAL (99511C Chassis):

Construction	Metal. Width to fit standard 19" equipment rack. Height 3 1/2". Depth 16". Slide mounted to fit 22" depth rack.
Size	21 lbs. Volume approximately .62 cubic feet.
Analog and digital modules	Plug in from the front without removing chassis from the rack.
Channels	Labeled 1 through 16 for analog signals and 17 through 20 for digital signals.
Chassis color and marking	Black. Lettering white with minimum height of 5/32 inch.
Input multiconductor connectors	Rear panel M81511/01ED01P1 (37 position) for digital input and M81511/01EF01P1 (85 position) for analog input.
Outputs	Single ended via insulated BNC connectors on the rear panel, labeled 1 through 20.
Wiring	Teflon insulated.

Temperature range:

Storage:	–55°C to +85°C
Operating:	–25°C to +55°C

Power–on light — A red pilot light is provided on the front panel.

1.3 ELECTRICAL (99511C Chassis)

Front panel power switch — Rear panel fuse module with detachable 3–prong line cord for ac power input.

Maximum power consumption — 25 watts (inputs shorted at 120 VAC line power).

Line power — 47 – 415 Hz. 120 VAC ±10% (108 – 132 VAC). Fuse is 1/2A 250V slow blow (5mm dia x 20mm long)

Output ground — All 20 output shields tie to floating power supply ground.

1.4 DIGITAL AMPLIFIER (99511B)

Channels per module — Four

Data rate — 2.4 kilobits to 256 kilobits per second.

Input — 5V TTL compatible logic level from JM38510/10403 line driver. (Fairchild μA9614).

Output — TTL compatible single ended output from JM38510/10404 line receiver (Fairchild μA 9615). Active pullup configuration. Non strobed. 130 ohm termination not implemented. Frequency response capacitor selected for 300 nanosecond internal time constant..

Series output resistance — 47Ω ±10%

Minimum differential mode signal for clean output — ±800 mV

Maximum input common mode for clean output — ±10V relative to output ground with ±5 volt differential input
±14V relative to output ground with 800mV differential input.

Maximum input without damage — ±25V dc or peak on either signal conductor relative to output ground with unit power turned on. (±10V with power off).

1.5 ANALOG AMPLIFIER (99511A):

(After 10 minute warm-up)

Channels per module	Two
Amplifier crosstalk	<70 dB, 5 Hz – 100 kHz.
Gain selection	0 dB (unity), 6 dB (two) or 12 dB (four) with ±0.1 dB "gain stability." This is interpreted to mean a gain accuracy of ±1% with output unloaded (includes initial accuracy and temperature drift effects).
Z in	68 MΩ differential and 84 MΩ common mode at 1 kHz.
Z out	50Ω (±2%) at 1 kHz.
Maximum input sinewave without distortion	7 V rms
Maximum undistorted output into 1 KΩ load	7 Vrms
Common mode rejection	60 dB at 5 Hz at gain of unity, two or four. 40 dB at 100 kHz at gain of unity, two or four.
Common mode range	Peak common mode plus signal without clipping relative to output ground. G = 1 (0 dB) ±10V G = 2 (6 dB) ±7.5V G = 4 (12 dB) ±6.25V
Overload protection	Damage protected from a 60 V rms sinewave input with outputs shorted.
Self noise	Noise at the outputs does not exceed –99 dBV (11.2 μV) in a 1 Hz to 200 kHz bandwidth at 25°C ambient with zero dB gain and input shorted.
Low frequency rolloff	–6dB per octave. 5 Hz cutoff frequency. The attenuation at 5 Hz shall be 3.1 dB ±0.1 dB with a phase angle of +50.8° ±1.7° (output leads input).

Frequency response and phase match

A single pole high frequency rolloff (-6 dB/octave) nominally at 100 kHz is provided.The attenuation at 100 kHz is –3 dB ±0.5 dB.

Frequency Hz	Amplitude dB	Phase Shift Degrees
100 K	–3 ±0.5	–48.5° ±2°
50 K	–1 ±0.2	–28° ±1.5°
20 K	–0.2 ±0.1	–12° ±1°
700	0.0 ±0.1	0° ±1°

Note that the single RC rolloff approximates a linear phase filter.

Selectable rolloff function cutoff and phase characteristics

The LP switch provides for two additional cutoff frequencies of 25 kHz and 5 kHz. The attenuation shall be –3 dB ±0.5 dB at the cutoff frequency. The phase and gain performance at other frequencies is summarized below.

Frequency selected 25 kHz:

Frequency Hz	Amplitude dB	Phase Shift Degrees
25 K	–3 ±0.5	–46° ±2°
12.5 K	–1 ±0.2	–27° ±1.5°
5 K	–0.2 ±0.1	–11.5° ±1°
400	0.0 ±0.1	0.0° ±1°

Frequency selected for 5 kHz:

Frequency Hz	Amplitude dB	Phase Shift Degrees
5 K	–3 ±0.5	–45° ±2°
2.5 K	–1 ±0.2	–27° ±1.5°
1 K	–0.2 ±0.1	–11.3° ±1°
150	0.0 ±0.1	0.0° ±1°

Total harmonic distortion

Full level output (7.07 V rms sinewave) with a 1 kΩ load:
0.05% at 1 kHz
0.10% at 50 kHz

SECTION 2

MODEL 99511A DUAL ANALOG AMPLIFIER

2.1 DESCRIPTION

This module consists of two identical circuits, one of which is described herein. The differential input is ac coupled at a 0.5 Hz nominal low frequency rolloff via capacitors C1 and C2 working with resistors R2 and R5. Accurate matching of the R2C1 and R5C2 time constants to ±2% is vital for attaining good low frequency common mode rejection. R1 and R4 in conjunction with D1 thru D4 protect against input overloads. U1A, U1B and U2A constitute a field effect transistor (FET), high input impedance, differential input, single ended output instrumentation amplifier. Its gain is settable to unity (0 dB), two (+6 dB) or four (+12 dB) depending on the position of S1. Trimpot R15 nulls the response to common mode interference.

Interstage highpass coupling components R26 and C11 roll off the response at –6 dB/octave below 5 Hz. C3, R16, R17 and R18 comprise a –6 dB/octave high frequency rolloff switchable for a 100 kHz, 25 kHz or 5 kHz –3 dB corner frequency. Mechanical front panel switch S2 controls electronic switch U4, which contains FET switches SD1 and SD2. These switches set the amount or resistance acting with C3 (350 pf including stray capacitance and optional trim capacitor C12), as shown below:

SD1	SD2	R	fc = 1/2πRC)
Open	Open	90.5K	100.4 kHz
Closed	Open	18.2K	25.0 kHz
Don't care	Closed	4.53K	5.02 kHz

U2B and U3 comprise the output driver. FET amp U2B buffers the highpass/lowpass filter network. Power buffer U3 provides the muscle to drive 10V pp into a 1KΩ load. Feedback resistor R22 forces the voltage seen at the junction of R23 and R25 to equal the output of the filter network. The voltage at this point represents an accurate signal level independent of output loading. Note that the 50Ω output resistor R23 in conjunction with an external load resistor R_L will result in a gain loss factor of $G_L = R_L/(R_L + 50)$. For example if R_L = 1K, then G_L= .9524 ($20 \log_{10} .9524 = -0.42$ dB loss)

R21, R22 and C4 stabilize the output circuit against peaking and oscillation. R23 and R25 limit the output current to ±150 mA to protect U3 against damage with the output shorted. Optional trim resistor R27 allows one to trim the output level upward to attain the specified passband gain (if required).

U1, U2 and U3 were chosen for wide bandwidth, low noise, performance. U1, U2, U3 and U4 were also chosen for low power supply current requirements. Each amplifier channel draws 15 mA from the ±15 volt supplies when driving a 7.07 V rms (±10V peak) sinewave into a 1KΩ load (30 mA per dual channel module). A complete 99511 system with all 16 analog channels delivering 7.07 V rms into 1KΩ loads with draw 250 mA from the ±15V supplies. If one attempts to drive a nominal 7.07 V rms output into a shorted load, the channel will draw 60 mA. The power supply will deliver 400 mA before losing regulation, which allows for normal functioning on the remaining channels with the outputs of one or two channels shorted to ground.

SECTION 3

MODEL 99511B QUAD DIGITAL AMPLIFIER

3.1 DESCRIPTION

This module contains four identical circuits implemented using two dual channel μA9615 integrated circuits (line receiver JM38510/10404). One of these channels is described herein. The μA9615 device is designed to receive differential digital data from a μA9614 differential line driver (JM38510/10403). Plus 800mV or greater on the (+) input relative to the (–) input constitutes a logical 1 (high level on the output pins). Minus 800 mV or below on the (+) input relative to the (–) input constitutes a logical 0 (low level on the output pins). The device operates on a single +5V ac supply. Nonetheless it will respond to ±800 mV of signal riding atop ±15V pp of common mode interference and deliver undisturbed TTL level logic to the output.

R1 and R2 in conjunction with D1 thru D4 provide protection for up to ±25V dc continuous inputs. Input voltage in excess of ±15V causes current to shunt thru the diodes into the ±15 power supply lines, which are brought on board solely to provide input protection potentials. The voltage limit is set by the power rating of 1/4 watt resistors R1 and R2: at V_{in} = 25Vdc, ΔV = 25–15V = 10V and $P = (\Delta V)^2/R$ = 100/470 = 0.215 W. Note that with the power supplies shut off, the protection network will withstand only ±10 Vdc or 10 V rms (28V pp sinewave).

The μA9615 device contains a 130Ω terminating resistor which is unused (pin 6 is left open). The 100pF capacitor on pin 4 slows the internal response time constant to approximately 300 nanoseconds in order to suppress noise. Output pin 1 (open collector) and output pin 2 (active pull–up) are tied together to yield a standard active pull–up/pull–down TTL drive capability.

The 47Ω output resistors suppress ringing and oscillation tendencies in the outputs when capacitatively loaded. The value of 47Ω limits overshoot to roughly 10% with several hundred picofarads of cable capacitance, yet allows enough output current to drive a standard TTL load.

The μA9615 draws 25 mA driving a standard TTL load. The four channel module thus pulls 50 mA from the +5V logic supply.

The guide pins for the 99511B Digital Amp board–to–chassis connectors are reverse keyed relative to the 99511A Analog Amp. This prevents mis–insertion of either board and the resultant possible electrical damage.

SECTION 4

MODEL 99511 CHASSIS POWER SUPPLY

4.1 DESCRIPTION

The power supply operates on 47 to 500 Hz, 105 to 135 Vac line power. Transformer T1 drives full wave, center–tapped, rectifier bridge D5–D8 with capability to provide a raw output of 7.8 Vdc at a full load current drain of 100 mA (9.3 Vdc @ 60 mA nominal load) with 120 Vac line input. Output ripple will be about 270 mV pp at full load. Transformer T2 drives dual complimentary rectifier bridge D1–D4 with capability to provide raw outputs of ±21 Vdc at a full load current drain of 400 mA (±24 V dc @ 250 mA nominal load) with 120 Vac line input. Output ripple will be about 1V pp at full load.

Regulator U1 drops the raw +24 Vdc to +15 Vdc and regulator U2 drops the raw –24Vdc to –15Vdc. Over a 5 mA to 400 mA load range, 105 to 135V ac input range and a –25°C to +55°C ambient temperature range, the outputs will remain within ±0.6V of nominal 15V for U1 and U2. Output ripple and noise will not exceed 1 mV rms.

Regulator U3 drops the raw 9.3Vdc to +5V. Over a 5 mA to 100 mA load range, 105–135Vac input range and a –25°C to +55°C ambient temperature range, the outputs will remain within ±0.2V of nominal 5.0V. Output ripple and noise will not exceed 1 mV rms.

At 120Vac input and nominal load (250mA on ±15V and 60 mA on +5V), the supply will draw 18 watts from the ac line. This is the expected typical dissipation with all 16 analog channels driving 1KΩ loads at full 7.07V rms output level. At low line level (105V) and full load (400mA), the onset of regulator dropout can be expected. The regulators U1, U2 and U3 incorporate safe area limiting for thermal overload protection and also current limiting for short duration faults. The practice of plugging–in and unplugging modules with power on is discouraged. However, it is recognized that such events will probably occur over the life of the instrument. This action causes the ±15V, +5V, and ground to be connected in an unknown and potentially harmful sequence. Protection diodes D9–D11 guard against damage to the power regulators by clamping the outputs to near ground potential. Similarly connected diodes on the individual module power supply inputs also substantially reduce the danger of damage by clamping the ±15V and +5V lines.

Capacitors C4–C6 prevent oscillations. Capacitors C7–C9 reduce output noise. Analog (±15V) ground and digital (+5V) ground are tied together on the power supply PC board but kept separate from chassis ground. At no point within the system does chassis ground (which is connected to the ac line input safety ground wire) make any connection with system power supply ground conductors. Shield wires on input cables are not continuous with system ground. System ground is tied to all output BNC output connector shields at the individual modules.

Resistor R1 limits the LED pilot light current to about 10 mA. Thus the total raw supply drain, including the 50 mA supplied to the 99511B Quad Digital Amplifier, comes to 60 mA.

SECTION 5

MAINTENANCE PROCEDURE

5.1 INTRODUCTION

This procedure tests a complete 99511 System with the digital amplifier module and all eight analog amplifier modules installed. It can be used for receiving acceptance, routine maintenance and troubleshooting purposes. Begin testing after a 10 minute warm–up. Recording of test results can be done on copies of the checkout forms appearing at the end of this section.

Tests should be done with both top and bottom chassis covers in place. The top cover may be removed only for those test steps which require access to internal test points or trimpots. The front panel module attachment captive screw must be firmly tightened for all tests.

5.2 POWER SUPPLY CHECK

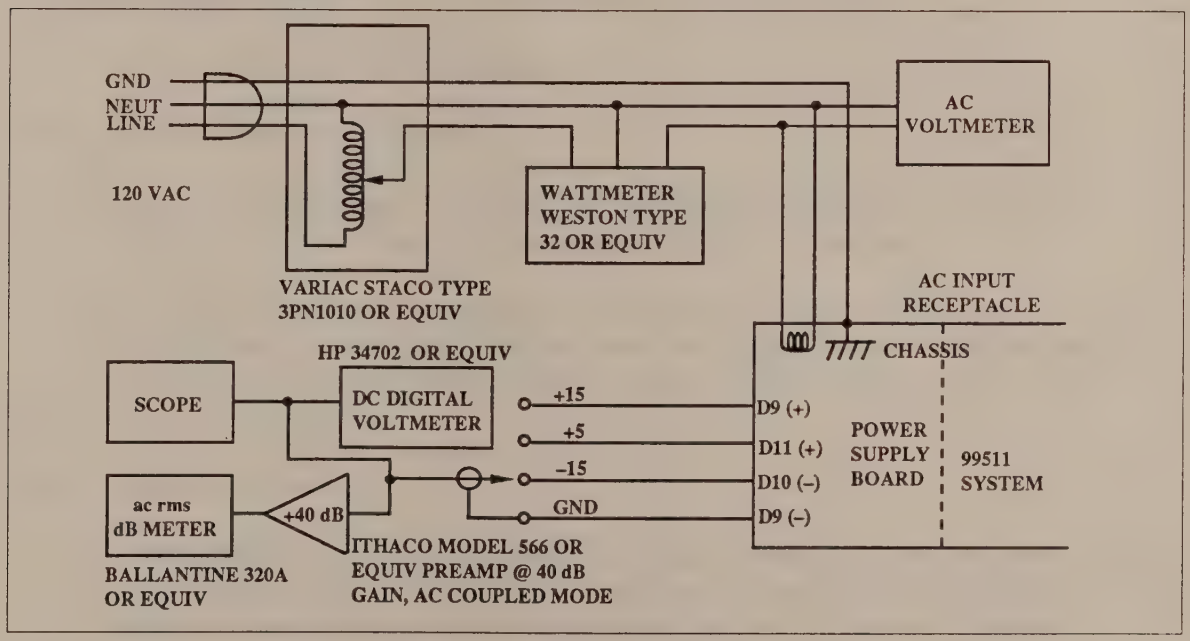


Figure 5.1 POWER SUPPLY CHECK SETUP

5.2.1 Conditions

All 20 channel inputs and outputs open circuited.
Variac output set to 120 Vac
Line Frequency at 60 Hz
566 Preamp ***must*** be in ac mode to protect it from damage due to dc overload

Use the scope, dc meter and ac rms dB meter to probe the power supply outputs with test common clipped to ground at 99511C chassis power supply board D9 (–) terminal. Find +15V @ D9 (+), –15V @ D10 (–) and +5V @ D11 (+) as shown in Figure 5.1. See Figure 6.9 for location of these diodes.

5.2.2 Power Consumption

Wattmeter Reading:	18W typical	25W maximum

5.2.3 Output Voltage

	Minimum	Maximum
+15V	+14.4	+15.6
–15V	–15.6	–14.4
+ 5V	+ 4.8	+ 5.2

5.2.4 Output Noise and Ripple

$$\text{Output noise} = \text{antilog}_{10}\left(\frac{\text{meter reading} - 40\text{ dB preamp gain}}{20}\right)$$

dB Meter Reading:	–20 dB maximum	–30 dB typical

Test the +15V, –15V and +5V supplies.

5.2.5 Line Regulation and Dropout

Adjust Variac output from 105 Vac to 135 Vac. The output should remain constant ±30 mV from 120 Vac reading for the +15V, –15V and +5Vsupplies.

Decrease the Variac until the regulator dropout threshold is reached as evidenced by a gross increase in output ripple (visible on scope using 100 mV/cm vertical gain, greater than –20 dB on dB meter). The threshold should occur below 105 Vac, for the +15V, –15V and +5V supplies.

5.2.6 400 Hz Line Input

Connect a 400 Hz line test source with output variable from 100 to 140 Vac to Wattmeter and ac voltmeter on input. Do not use Variac unless it is rated for 400 Hz (Stanco 3PN101D is ***not*** rated for 400 Hz). Repeat tests 5.2.2, 5.2.3, 5.2.4 and 5.2.5 above.

5.3 ANALOG AMPLIFIER TESTS

All channels 1 thru 16 are checked. Do steps 5.3.1 thru 5.3.3.1 for the first channel, then repeat for each successively higher channel. Make input connections at the rear panel 85 pin analog input receptacle per Figure 6.4. Outputs are monitored at the rear panel BNC receptacles numbered 1 thru 16.

The common mode rejection ratio (CMRR) trimpot adjustment must be checked before doing the gain accuracy tests. Misadjustment of CMRR may result in out–of–specification gain performance. CMRR trimming is done with the amplifier module under test in chassis slot position number 1 and the other slots empty. This affords screwdriver access to trimpots R15 and R115.

5.3.1 Setup for Common Mode Adjustment

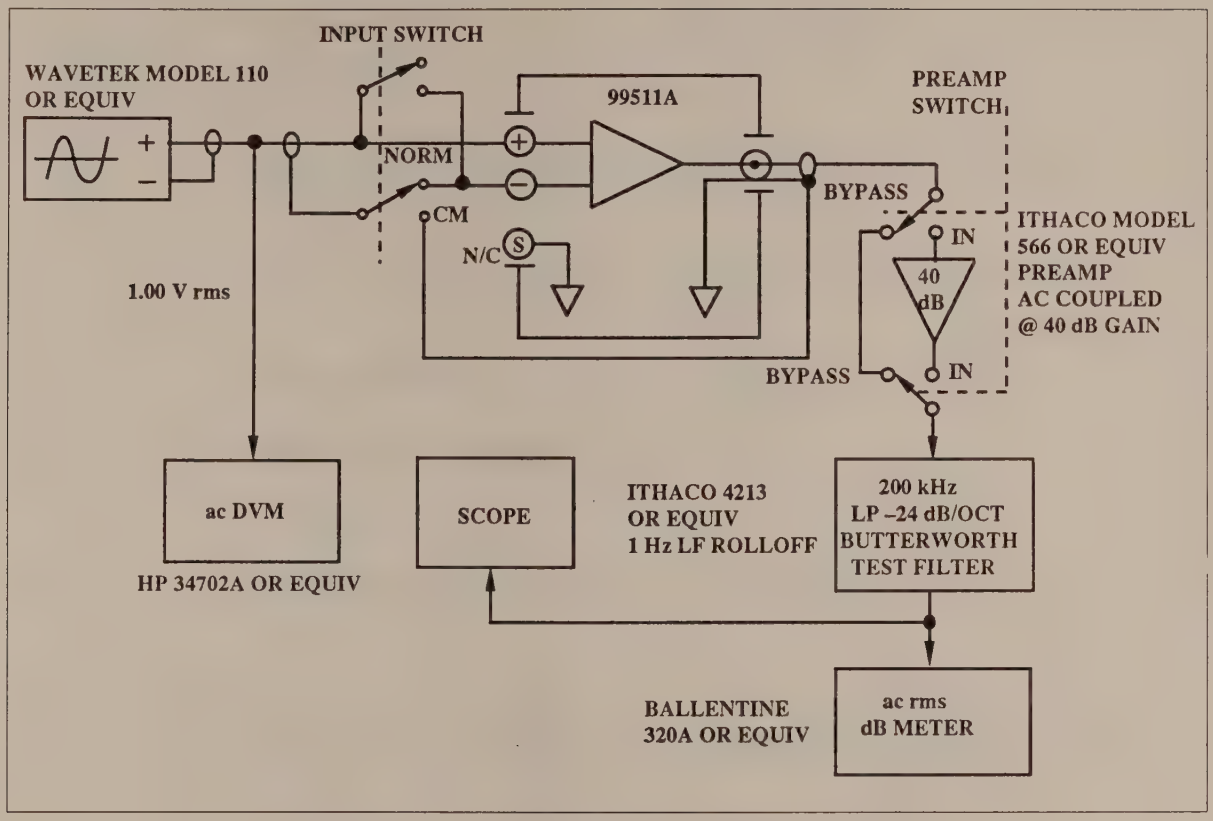


FIGURE 5.2 COMMON MODE ADJUSTMENT SETUP

5.3.1.1 Normal Mode Signal Check

Preamp Switch:	Bypass
Input Switch:	Norm
Signal:	1.00 ±0.01 V rms sinewave
Oscillator Frequency:	700 Hz ±10 Hz
99511 Amplifier Rolloff Switch:	100 kHz
99511 Amplifier Gain Switch:	0 dB
Test Filter LP Setting:	200 kHz
Test Filter HP Setting:	1 Hz
Preamp Gain:	40 dB
Preamp Mode:	566 ***must*** be ac coupled to prevent damage

Verify that the 99511A functions normally by observing the output on the scope and ac rms dB meter. The output should match in input in phase, be free of visible waveform distortion (clipping, etc), and be at a level of approximately 1.00 V rms (± several percent).

5.3.1.2 Common Mode Calibration at 700 Hz

Conditions:	Per 5.3.1.1 except:
Preamp switch:	In
Input switch:	CM

Adjust trimpot R15 for a minimum reading on dB meter for channel A (channel 1). For channel B (channel 2), adjust R115.

CMRR = ac rms dB meter reading – preamp gain = meter reading – 40 dB

	Maximum	Typical
dB Meter Reading:	–20 dB	–45 dB

5.3.1.3 Common Mode Checks at 5 Hz and 100 kHz

Conditions: Per 5.3.1.2

Observe dB meter for the gains and frequencies tabulated below:

OSCILLATOR FREQUENCY	GAIN SETTING	MAX ALLOWABLE dB METER READING
5 Hz	0 dB	–20 dB
5 Hz	6 dB	–14 dB
5 Hz	12 dB	– 8 dB
100 kHz	0 dB	0 dB
100 kHz	6 dB	+ 6 dB
100 kHz	12 dB	+12 dB

5.3.2 Setup for Gain, Drive, Impedance and Phase Checks

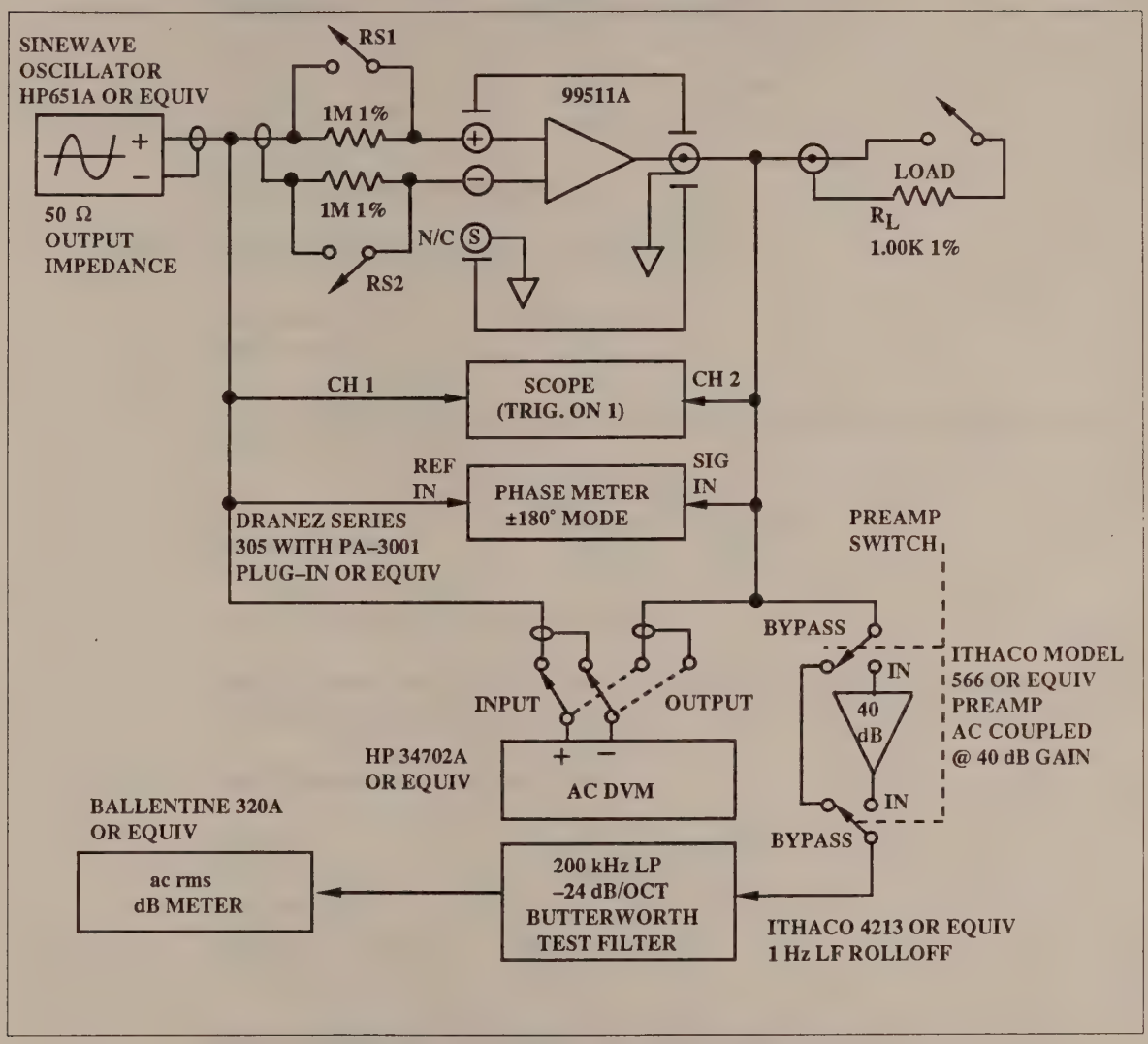


Figure 5.3 GAIN, DRIVE, IMPEDANCE AND PHASE CHECK SETUP

5.3.2.1 Gain Test at 1 kHz

Rolloff Switch:	100 kHz
Oscillator Frequency:	1 kHz
Oscillator Level:	1.750 Vrms ±0.005
Output Load:	Disconnected (R_L open)
Input Impedance:	Low (RS1, RS2 shorted)
Preamp Switch:	Bypass

Connect signal input to channel under test. Use oscilloscope to verify that the output is in phase with the input and not reversed in polarity. With ac DVM monitoring the input, adjust oscillator output for 1.750 ±0.005 V rms. Switch the DVM to the output and verify the following:

Gain Switch	Output Level (V rms)	
	Minimum	Maximum
0 dB	1.730	1.770
6 dB	3.460	3.540
12 dB	6.920	7.080

dB gain = 20 $\log_{10}$ (reading/input)

5.3.2.2 Output Impedance and Drive Check at 1 kHz

Conditions: Per 5.3.2.1
Gain Switch: 12 dB

Apply the 1kΩ load to the output. The output should drop –4.67% from a nominal 7.000 V (ΔV = 333 mV).

	Minimum	Maximum
ΔV on ac DVM:	0.325	0.340

$Z_{out} = [(V_{UNLOAD}/V_{LOAD}) - 1)] \times 1K\Omega$

View the output on the scope. There should be no clipping or distortion visible for the sinewave output.

5.3.2.3 Input Impedance Check @ 10 Hz

Conditions: Per 5.3.2.1 (except *)
Output Load: Disconnected
Gain Switch: 12 dB
*Oscillator Frequency: 10 Hz ±0.1 Hz
Oscillator Level: Approx. 1.75V

Adjust oscillator level for a 7.00 Vrms level seen at the output of the 99511A. Apply the 1 MΩ input series resistors (RS1 and RS2 not shorted). The output should drop 2.94% (ΔV = 206 mV)

	Minimum	Maximum
Output reading on ac rms dB meter	6.78	6.81

$Z_{in} = 2M (7.00/\text{reading} - 1)$

5.3.2.4 5 Hz Low Frequency Rolloff Response Check @20 Hz

Conditions: Per 5.3.2.1 (Except *)
*Oscillator Frequency: 20 Hz ±0.1 Hz
Gain Switch: 12 dB
Input Impedance: Low (RS1 and RS2 shorted)

This is done indirectly by making a phase measurement at 20 Hz rather than making an amplitude measurement at 5 Hz. This circumvents problems arising from the inaccuracy of many instruments when dealing with subsonic frequencies.

	Minimum	Maximum
Phasemater Reading:	+14.8°	+16.2°

$fc \cong 0.336\text{Ø} - 0.17$ Hz

5.3.2.4.1 Low Frequency Rolloff Slope Check @ 1.25 Hz

This step verifies that the response rolls off at –6 dB/octave below the 5 Hz LF cutoff point.

99511A Gain:	12 dB
Oscillator:	Wavetek 110 or equiv.
Waveform:	Sine
Frequency:	1.25 Hz (0.800 ±0.010 second period) Monitor frequency with counter in "period" mode
Scope Volts/Div:	1 V/div
Scope Sweep:	2 sec/div
Scope Coupling:	dc

Monitor the oscillator drive level and the 99511A channel output using two scope channels. Zero adjust both slope traces to the center horizontal axis with the inputs grounded. Switch on the inputs to dc mode. Adjust oscillator level for a 4V pp (4 divisions) drive swing. The 99511A channel output should also swing 4V pp ±10% (±0.4 div pp).

The output should match the input because the signal is two octaves below cutoff. We expect an attenuation given by $1 / \sqrt{1 + (fc/f)^2} = 1 / \sqrt{1 + (5/1.25)^2} = .2425$ or –12.30 dB. Since the amplifier gain is set to +12 dB, the result will be –0.3 net loss (output = 0.97 x input). Putting it another way, the attenuation slope is given by:

$$\text{dB/oct} = 20 \log_{10} \left(\frac{\text{reading in divisions}}{\text{oscillator output in divisions}} \times \frac{1}{\text{net loss}} \times \frac{1}{\text{number of octaves}} \right)$$

$$= 20 \log_{10} \left(\text{reading}/4/.97/2 \right) = 20 \log_{10} (\text{reading} \times 0.1289)$$

5.3.2.5 Crosstalk Test @ 100 kHz

Conditions:	Per 5.3.2.1 (except *)
*Oscillator Frequency:	100 kHz
*Oscillator Level:	1.00 Vrms
99511AGain Switches:	0 dB (Both channel under test and ***other*** channel)
99511A Rolloff Switches:	100 kHz (Both channel under test and ***other*** channel)
Test Filter Bandwidth:	1 Hz to 200 kHz
*Preamp Switch:	In
Preamp Gain:	40 dB
Preamp Mode:	566 ***must*** be ac coupled to prevent damage

Short the input to the ***other*** channel on the board under test (e.g. channel 8 if you have been testing channel 7). Jumper the (+) and (–) inputs of the ***other*** channel to one another and to output BNC ground of the ***other*** channel. Connect the preamp, filter and ac dB meter to the BNC output of the ***other*** channel to monitor the amount of signal being coupled out of the channel under test to the adjacent channel.

	Maximum
dB Meter Reading:	–30 dB (e.g. –25 dB is bad, –35 dB is good)

Crosstalk = meter reading –40 dB

Similarly test the channels on the boards physically adjacent to the board under test (e.g. channels 5, 6, 9 and 10 if signal were being applied to channel 7, etc.)

5.3.2.6 Noise Test

Conditions:	Per 5.3.2.1 (except *)
*Input:	Shorted (+) to (–) to BNC output ground for channel under test
Oscillator:	Disconnected
Gain Switch:	0 dB
Test Filter Bandwidth:	1 Hz to 200 kHz
*Preamp Switch:	In
Preamp Gain:	40 dB
Preamp Mode:	566 ***must*** be ac coupled to prevent damage

Reconnect the preamp, filter and ac rms dB meter to the output of the channel under test.

	Maximum
dB Meter Reading:	–59 dB (11.2 µV rms) (e.g. –58 dB is bad, –60 dB is good)

Noise = meter reading –40 dB

5.3.2.7 High Frequency Cutoff and Phase Response

Conditions:	Per 5.3.2.1 (except *)
*Oscillator Level:	1.000 Vrms ±0.001 V rms
Preamp Switch:	Bypass

Check the 100 kHz, 25 kHz and 5 kHz rolloff characteristics per the tables below. Each time the oscillator frequency is adjusted, recheck the input level (which may have changed) and reset for 1.000 V rms ±0.001 V rms.

ROLLOFF SETTING	OSCILLATOR FREQUENCY (±1%)	AMPLITUDE MINIMUM	V rms MAXIMUM	PHASE DEGREES MINIMUM	PHASE DEGREES MAXIMUM
100K	200K	–	0.500	N/A	N/A
100K	100K	0.67	0.75	–50	–46
100K	50K	0.87	0.91	–29.5	–26.5
100K	20K	0.966	0.989	–13	–11
100K	700	0.989	1.012	–1.0	+1.0
25K	25K	0.67	0.75	–48	–44
25K	12.5K	0.87	0.91	–28.5	–25.5
25K	5K	0.966	0.989	–12.5	–10.5
25K	400	0.989	1.012	–1.0	+1.0
5K	5K	0.67	0.75	–47	–43
5K	2.5K	0.87	0.91	–28.5	–25.5
5K	1K	0.966	0.989	–12.3	–10.3
5K	150	0.989	1.012	–1.0	+1.0

db rolloff = 20 $\log_{10}$ (reading)

5.3.3 Setup for Distortion Test

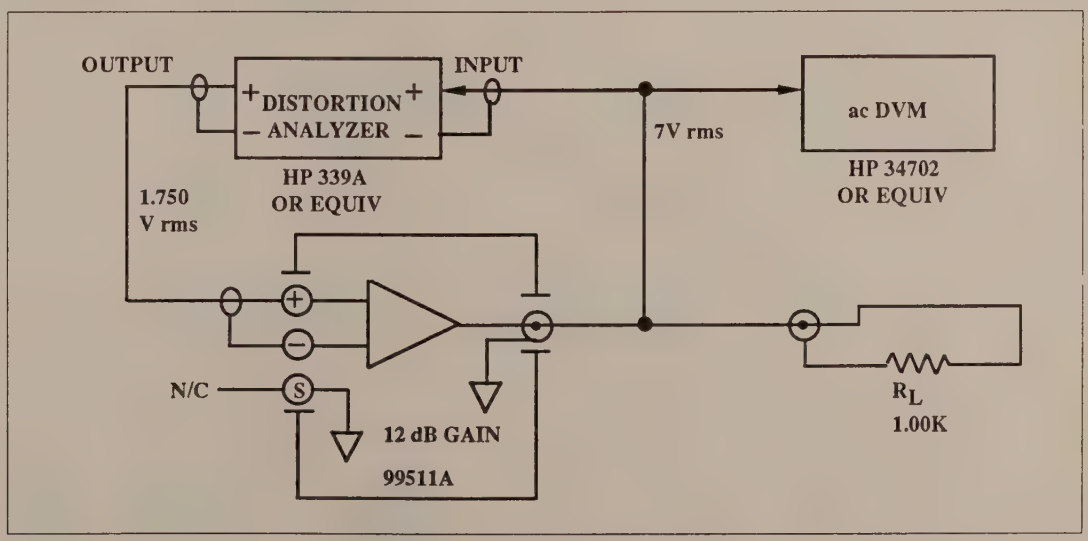


Figure 5.4 DISTORTION TEST SETUP

5.3.3.1 Distortion Test at 1 kHz and 50 kHz

HP339A Output Level:	1.750 V rms
99511AGain Switch:	12 dB
99511A Rolloff:	100 kHz
99511A Output:	7 V rms
Load:	1.00K

Check for distortion readings:

Oscillator Frequency	Maximum Reading
1 kHz	0.05%
50 kHz	0.10%

5.4 DIGITAL AMPLIFIER TESTS

Do steps 5.4.1 thru 5.4.3 for each of channels 17 thru 20 in succession. Make input connections only to channel under test (do not parallel inputs) at the 37 pin, rear panel, digital input receptacle per Figure 6.5. Outputs are monitored at the rear panel BNC connectors numbered 17 thru 20.

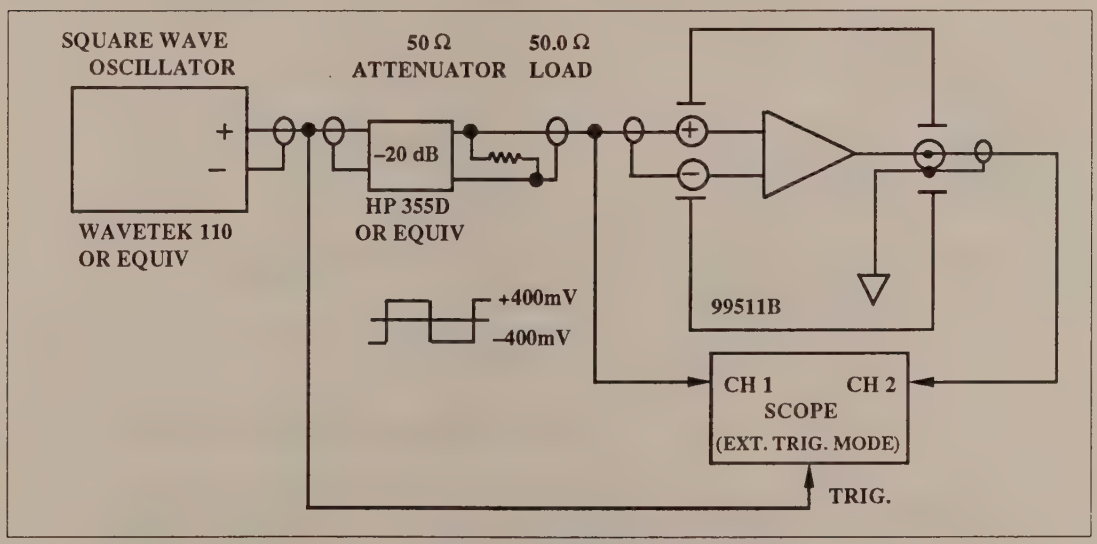


Figure 5.5 DIGITAL AMPLIFIER TEST SETUP

5.4.1 Output Swing and Polarity

Oscillator Output:	Square wave
Oscillator Frequency:	100 kHz
Attenuator:	–20 dB
Drive:	800mV pp to 99511B input

Compare input to output on scope. The output waveform should be in phase with the output (***not*** inverted relative to the input). The output should swing from +0.2V or below to +3.2V or greater.

5.4.2 Frequency Response

Oscillator Frequency:	1 MHz
Attenuator:	–20 dB
Drive:	800 mV pp to 99511B input

View output waveform on scope. It should swing from below 0.2V to above 3.2V. The risetime and ringing details will vary depending on whether a scope probe or BNC cable is used to connect the output to the scope and also on the length, branching, impedance and capacitance of the BNC cabling attached to the output. Both cable capacitance slowing of risetime effects and cable reflection ringing effects may be observed. Using a 10 foot length of unterminated 50Ω cable (e.g. Belden RG–58/U), the risetime must be fast enough to slew to the upper and lower voltage limits given above. Overshoot and ringing shall not exceed 500 mV in amplitude.

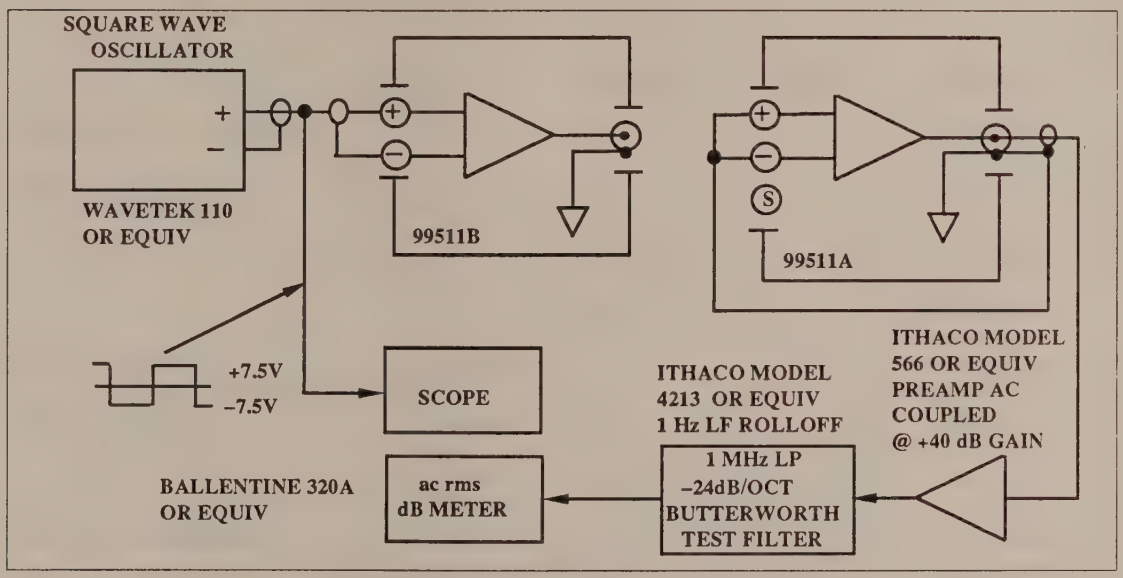


Figure 5.6 DIGITAL TO ANALOG CROSSTALK SETUP

5.4.3 Crosstalk to Analog Channels 15 and 16

Oscillator Frequency:	100 kHz
Oscillator Output:	15V pp square wave drive to 99511B input
Test Filter Bandwidth:	1 Hz LF, 1 MHz HF
99511A Module Gain:	0 dB
99511A Module Rolloff:	100 kHz
Preamp Mode:	***Must*** be ac coupled to prevent damage

Check the bleed into analog channels 15 and 16 from the digital channel under test using the setup shown in Figure 5.6.

The 15 pp square wave contains a 6.76 volt rms sinewave fundamental component (+16.6 dB)

Spec limit + input drive + preamp gain = max reading

–70 dB + 16.6 dB + 40 dB = –13.4 dB max
(e.g. –13 dB is bad, –14 dB is good)

99511C POWER SUPPLY

Test Data Sheet 1 of 1

Chassis # _____

Serial # _____ Line Frequency

Date _____ 60 Hz ☐

Temperature _____ °C 400 Hz ☐

Operator _____

			Mininum	Reading	Maximum
5.2.2	POWER CONSUMPTION		—	_____	25.0 Watts
5.2.3	OUTPUT VOLTAGE	+15V	+14.40	_____	+15.60
		–15V	–15.60	_____	–14.40
		+5V	+4.8V	_____	+5.2V
5.2.4	OUTPUT NOISE $\text{noise} = \text{antilog}_{10}\left(\frac{\text{reading} - 40\text{ dB}}{20}\right)$	+15V	—	_____	–20 dB
		–15V	—	_____	–20 dB
		+5V	—	_____	–20 dB
5.2.5	LINE REGULATION	+15V	—	_____	±30mV dc
		–15V	—	_____	±30mV dc
		+5V	—	_____	±30mV dc
		Dropout	—	_____	105 Vac

99511A ANALOG AMPLIFIER
Test Data Sheet 1 of 2

Serial #_____ Temperature_____ °C

Date _____ Operator _____

Channel A (odd) ☐ B (even) ☐

Chassis # _____

Channel # _____ Slot #_____

			Minimum	Reading	Maximum dB
5.3.1.2	COMMON MODE CALIB @ 700 Hz:		—	_____	–20 dB
	CMRR = reading –40 dB				
5.3.1.3	COMMON MODE REJECTION @ 5 Hz and 100 kHz				
	CMRR = reading –40 dB				
	Oscillator	Gain			
	5 Hz	0 dB	—	_____	–20 dB
	5 Hz	6 dB	—	_____	–14 dB
	5 Hz	12 dB	—	_____	– 8 dB
	100 kHz	0 dB	—	_____	0 dB
	100 kHz	6 dB	—	_____	+ 6 dB
	100 kHz	12 dB	—	_____	+12 dB
5.3.2.1	GAIN @ 1 kHz				
	dB = 20 $\log_{10}$ (reading/input)				
	Input		1.745	_____	1.755 V rms
	Output @ 0 dB		1.730	_____	1.770 V rms
	Output @ 6 dB		3.460	_____	3.540 V rms
	Output @ 12 dB		6.920	_____	7.080 V rms
5.3.2.2	50Ω OUTPUT IMPEDANCE @ 1 kHz				
	$Z_{out} = (V_{UNLOAD}/V_{LOAD} - 1) \times 1k\Omega$				
	Output Unloaded		6.920	_____	7.080 V rms
	Output Loaded		—	_____	—
	ΔV Out (subtract)		0.325	_____	0.340 V rms
5.3.2.3	66MΩ INPUT IMPEDANCE @ 10 Hz				
	$Z_{in} = 2M\Omega/(V_{LOZ}/V_{HIZ} - 1)$				
	Output @ Lo Z		6.99	_____	7.01 V rms
	Output @ Hi Z		6.78	_____	6.81 V rms
5.3.2.4	LOW FREQ ROLLOFF @ 20 Hz				
	$f_L \cong 0.336Ø - 0.17$ Hz				
	Phase		14.8	_____	16.2 degrees
5.3.2.4.1	LOW FREQUENCY ROLLOFF				
	SLOPE CHECK @ 1.25 Hz				
	dB/oct = 20 $\log_{10}$ (reading x 0.1289)		3.6	_____	4.4 divisions

99511A ANALOG AMPLIFIER

Test Data Sheet 2 of 2

Serial # _____ Temperature _____ °C

Date _____ Operator _____

Channel A (odd) ☐ B (even) ☐

Chassis # _____

Channel # _____ Slot # _____

		Minimum	Reading	Maximum
5.3.2.5	CROSSTALK @ 100 kHz crosstalk = meter reading – 40 dB			
	Largest dB Meter Reading	—	_____	–30 dB
	On Channel #		_____	Channel #
5.3.2.6	NOISE noise = meter reading – 40 dB	—	_____	–59 dB

5.3.2.7 CUTOFF @ PHASE RESPONSE

		Amplitude V rms			Phase Degrees		
Rolloff	Oscillator	Min	Reading	Max	Min	Reading	Max
100K	200K	—		0.50	N/A		N/A
100K	100K	0.67		0.75	–50		–46
100K	50K	0.87		0.91	–29.5		–26.5
100K	20K	0.966		0.989	–13		–11
100K	700	0.989		1.012	+1.0		–1.0
25K	25K	0.67		0.75	–48		–44
25K	12.5K	0.87		0.91	–28.5		–25.5
25K	5K	0.966		0.989	–12.5		–10.5
25K	400	0.989		1.012	–1.0		+1.0
5K	5K	0.67		0.75	–47		–43
5K	2.5K	0.87		0.91	–28.5		–25.5
5K	1K	0.966		0.989	–12.3		–10.3
5K	150	0.989		1.012	–1.0		+1.0

		Minimum	Reading	Maximum
5.3.3.1	DISTORTION			
	@ 1 kHz	—	_____	(0.05%)
	@ 50 kHz	—	_____	(0.10%)

99511B DIGITAL AMPLIFIER

Test Data Sheet 1 of 1

Chassis # _____ Installed ☐ Spare ☐

Serial # _____ Temperature _____ °C

Date _____ Operator _____

			Minimum	Reading	Maximum
5.4.1	OUTPUT SWING AND POLARITY				
	CHANNEL A (17)	High	3.2	_____	5.2V
		Low	0.0	_____	0.2 V
	CHANNEL B (18)	High	3.2	_____	5.2 V
		Low	0.0	_____	0.2 V
	CHANNEL C (19)	High	3.2	_____	5.2 V
		Low	0.0	_____	0.2 V
	CHANNEL D (20)	High	3.2	_____	5.2 V
		Low	0.0	_____	0.2 V
5.4.2	FREQUENCY RESPONSE @ 1 mHz				
	CHANNEL A (17)	High	3.2	_____	5.2V
		Low	0.0	_____	0.2 V
	CHANNEL B (18)	High	3.2	_____	5.2 V
		Low	0.0	_____	0.2 V
	CHANNEL C (19)	High	3.2	_____	5.2 V
		Low	0.0	_____	0.2 V
	CHANNEL D (20)	High	3.2	_____	5.2 V
		Low	0.0	_____	0.2 V

5.4.3 CROSSTALK TO CHANNELS 15 and 16

crosstalk = reading –56.6 dB

Digital Channel	Minimum	Analog Channel Reading		Maximum
		Chan A (15)	Chan B (16)	
A (17)	—	_____	_____	–13.4 dB
B (18)	—	_____	_____	–13.4 dB
C (19)	—	_____	_____	–13.4 dB
D (20)	—	_____	_____	–13.4 dB

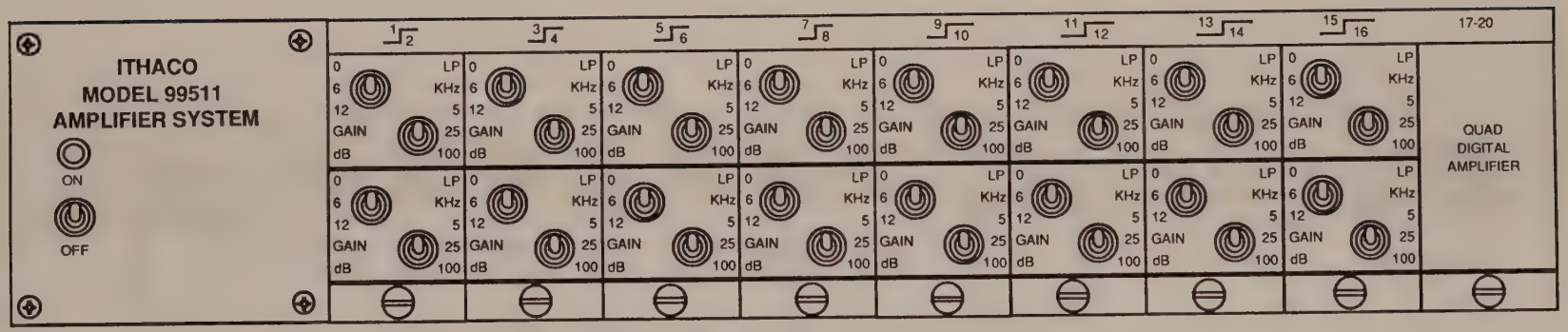


Figure 6.1 MODEL 99511 FRONT VIEW

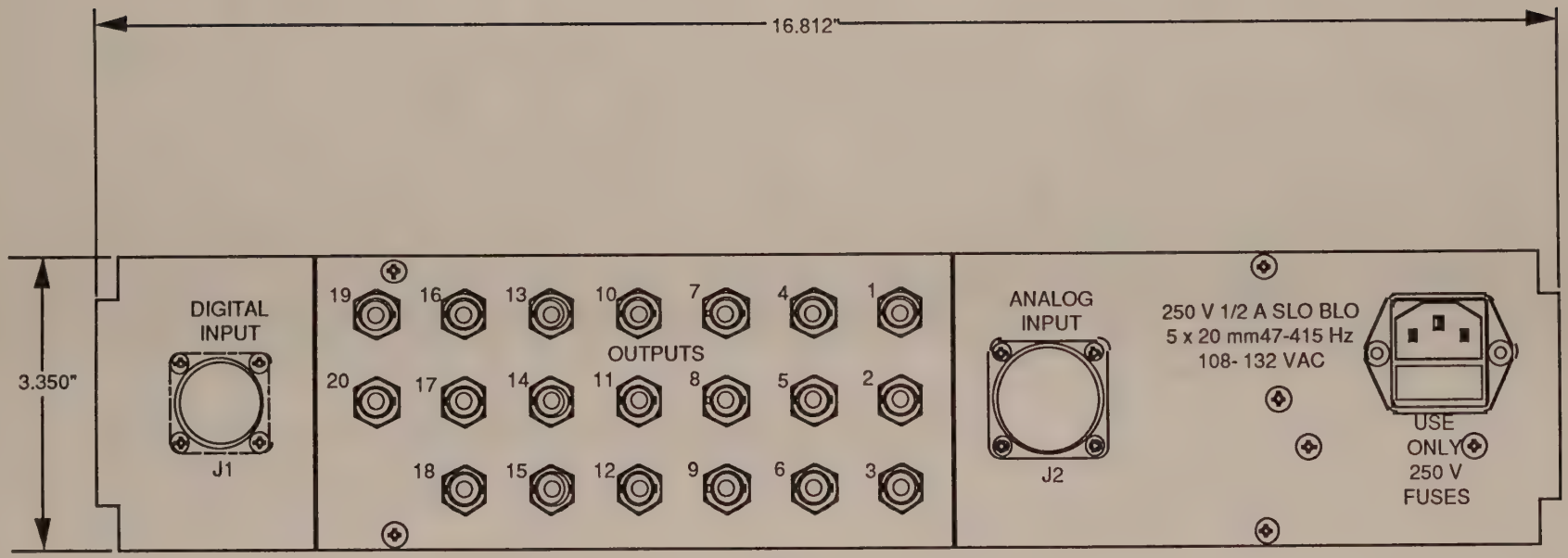


Figure 6.2 MODEL 99511 REAR VIEW

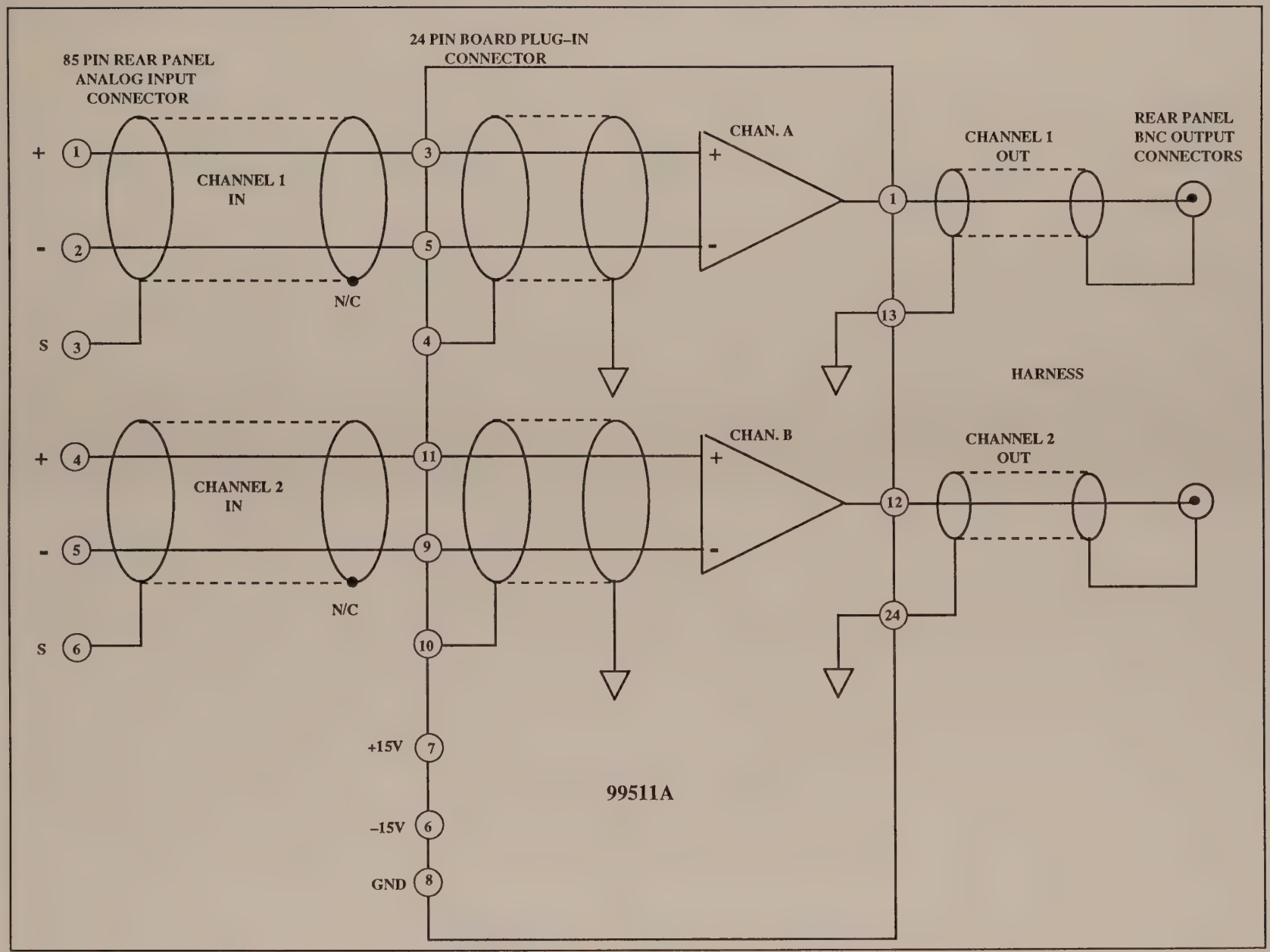


FIGURE 6.3 ANALOG I/O WIRING, FIRST OF 8 BOARDS

BOARD	1	2	3	4	5	6	7	8
CHAN	1	3	5	7	9	11	13	15
(+)	1	7	13	20	28	34	40	46
(–)	2	8	14	21	29	35	41	47
S	3	9	15	22	30	36	42	48
CHAN	2	4	6	8	10	12	14	16
(+)	4	10	17	25	31	37	43	51
(–)	5	11	18	26	32	38	44	52
S	6	12	19	27	33	39	45	53

Figure 6.4 INPUT WIRING TABLE FOR THE 16 ANALOG CHANNELS TO 85 PIN REAR PANEL CONNECTOR

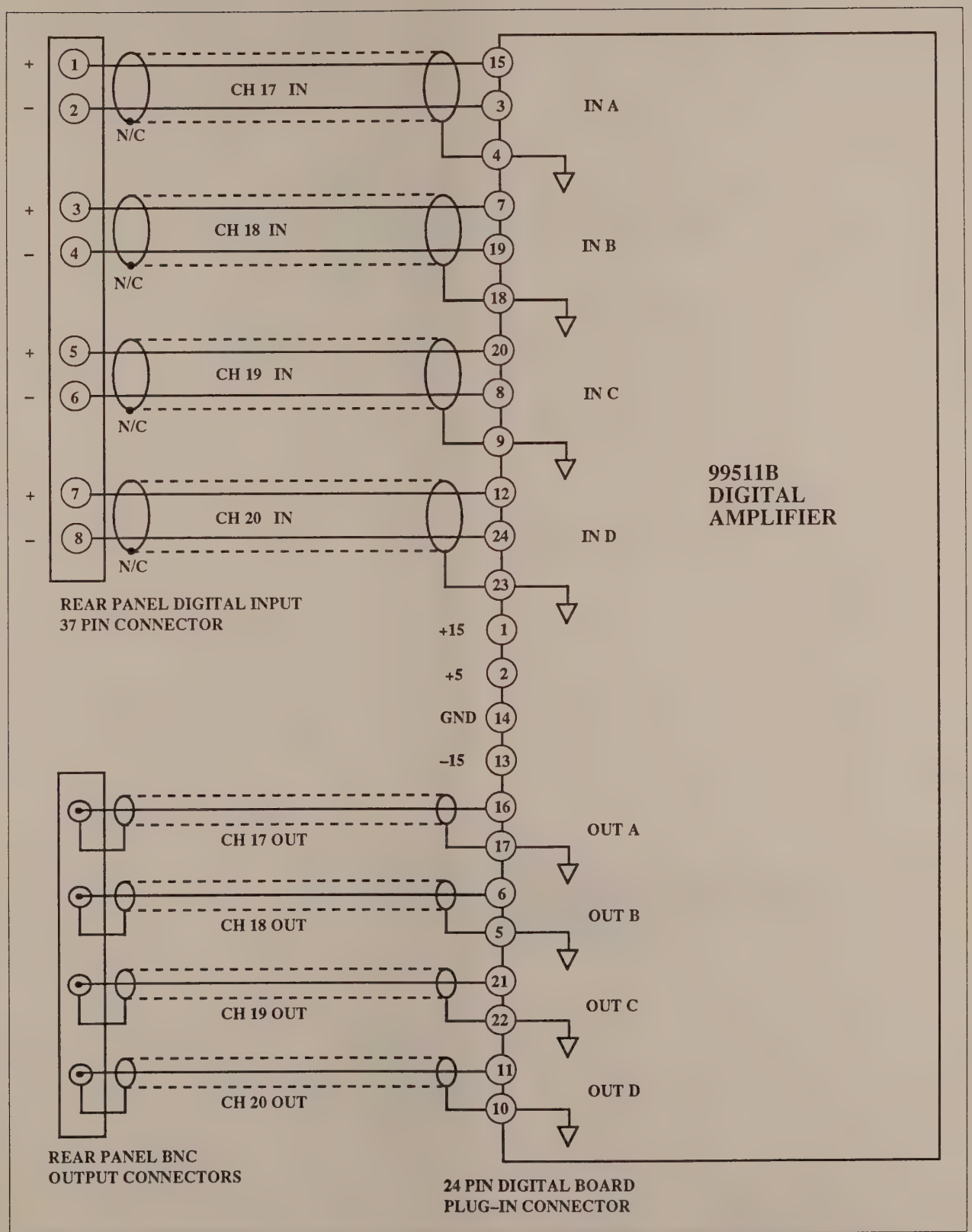
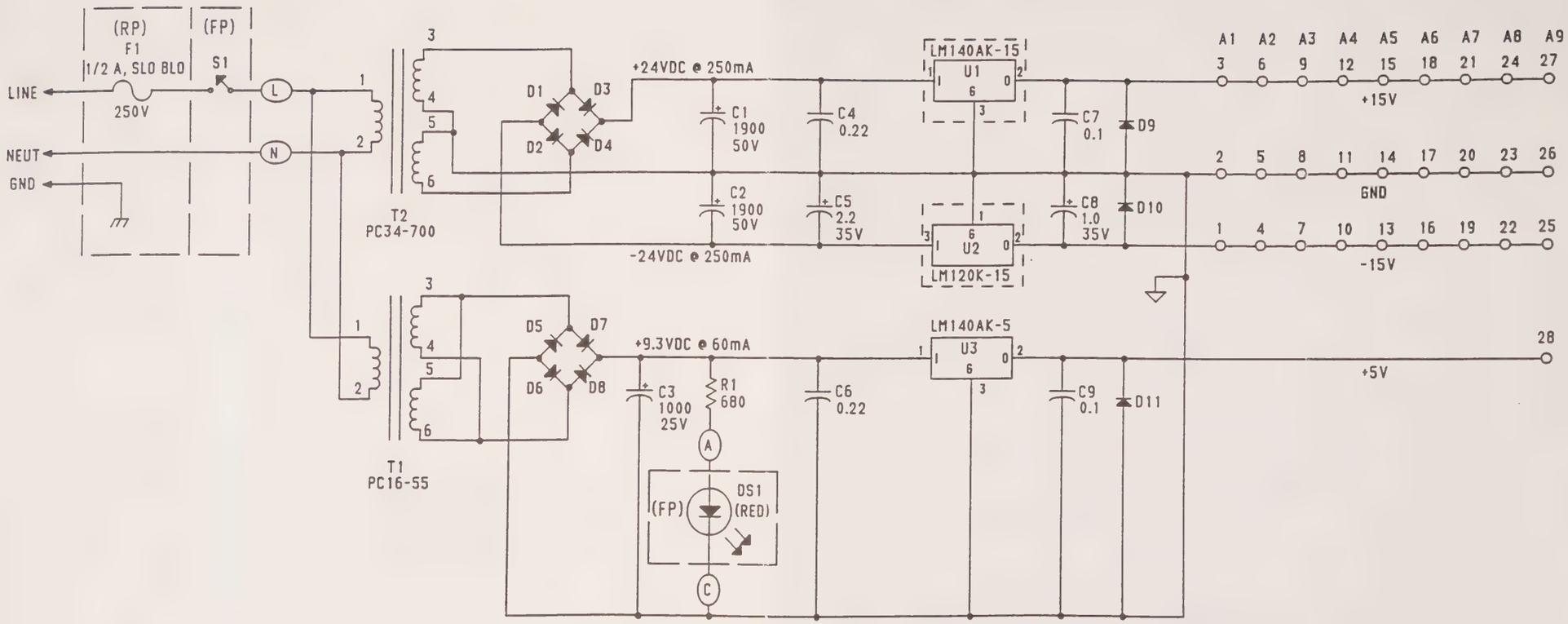
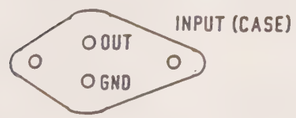


Figure 6.5 DIGITAL I/O WIRING



U1,U3 BOTTOM VIEW

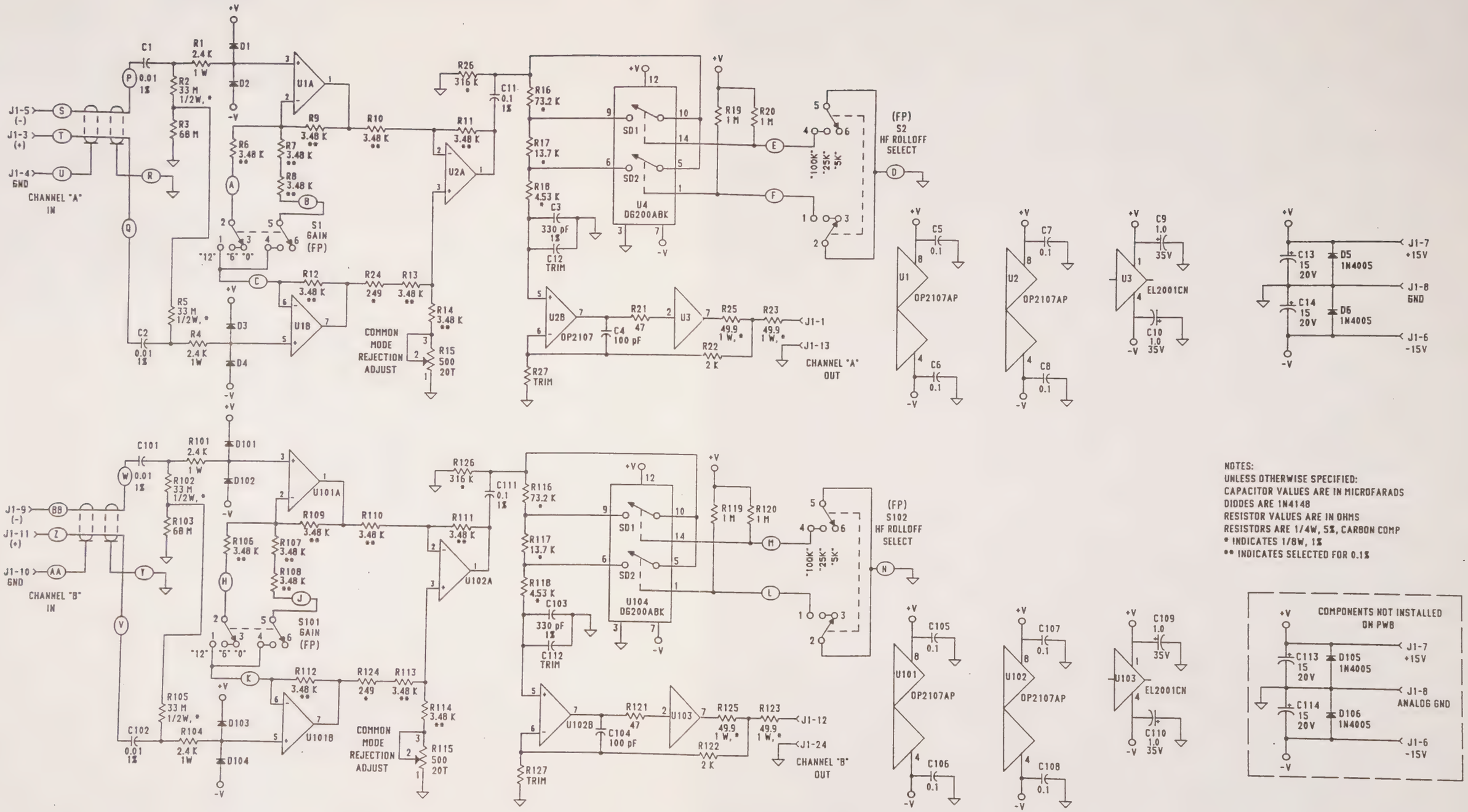
U2 BOTTOM VIEW



NOTES:
UNLESS OTHERWISE SPECIFIED
CAPACITOR VALUES ARE IN MICROFARADS
DIODES ARE 1N4005
RESISTOR VALUES ARE IN OHMS

ITHACO DWG C33320 10/90

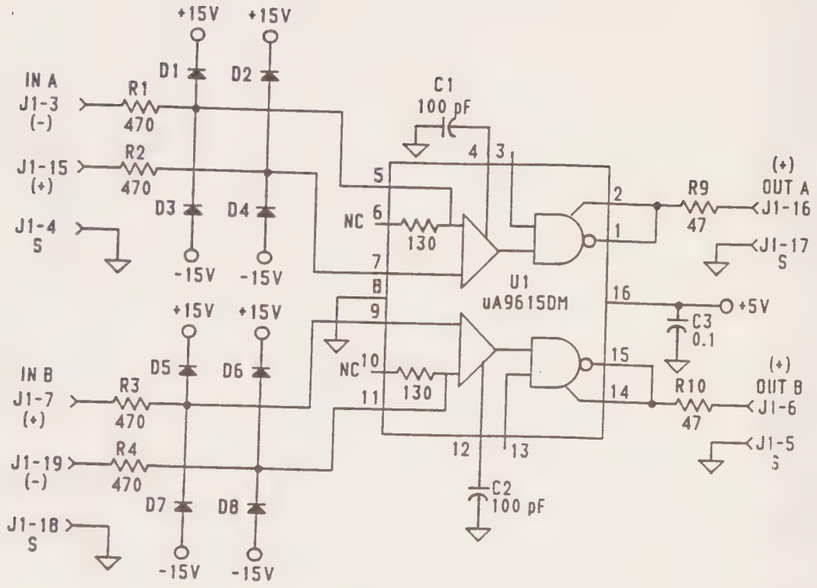
FIGURE 6.6
ITHACO MODEL 99511-C
POWER SUPPLY
SCHEMATIC

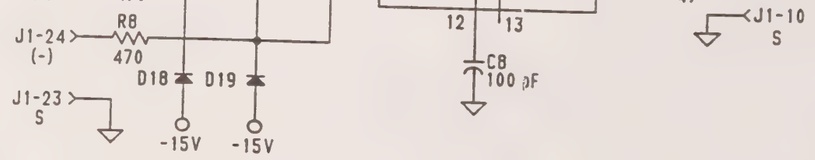


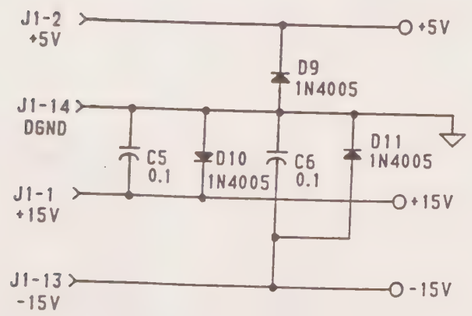
NOTES:
UNLESS OTHERWISE SPECIFIED:
CAPACITOR VALUES ARE IN MICROFARADS
DIODES ARE 1N4148
RESISTOR VALUES ARE IN OHMS
RESISTORS ARE 1/4W, 5%, CARBON COMP
* INDICATES 1/8W, 1%
** INDICATES SELECTED FOR 0.1%

ITHACO DWG D43384 9/90

FIGURE 6.7
ITHACO MODEL 99511-A
DUAL CHANNEL ANALOG AMPLIFIER
SCHEMATIC



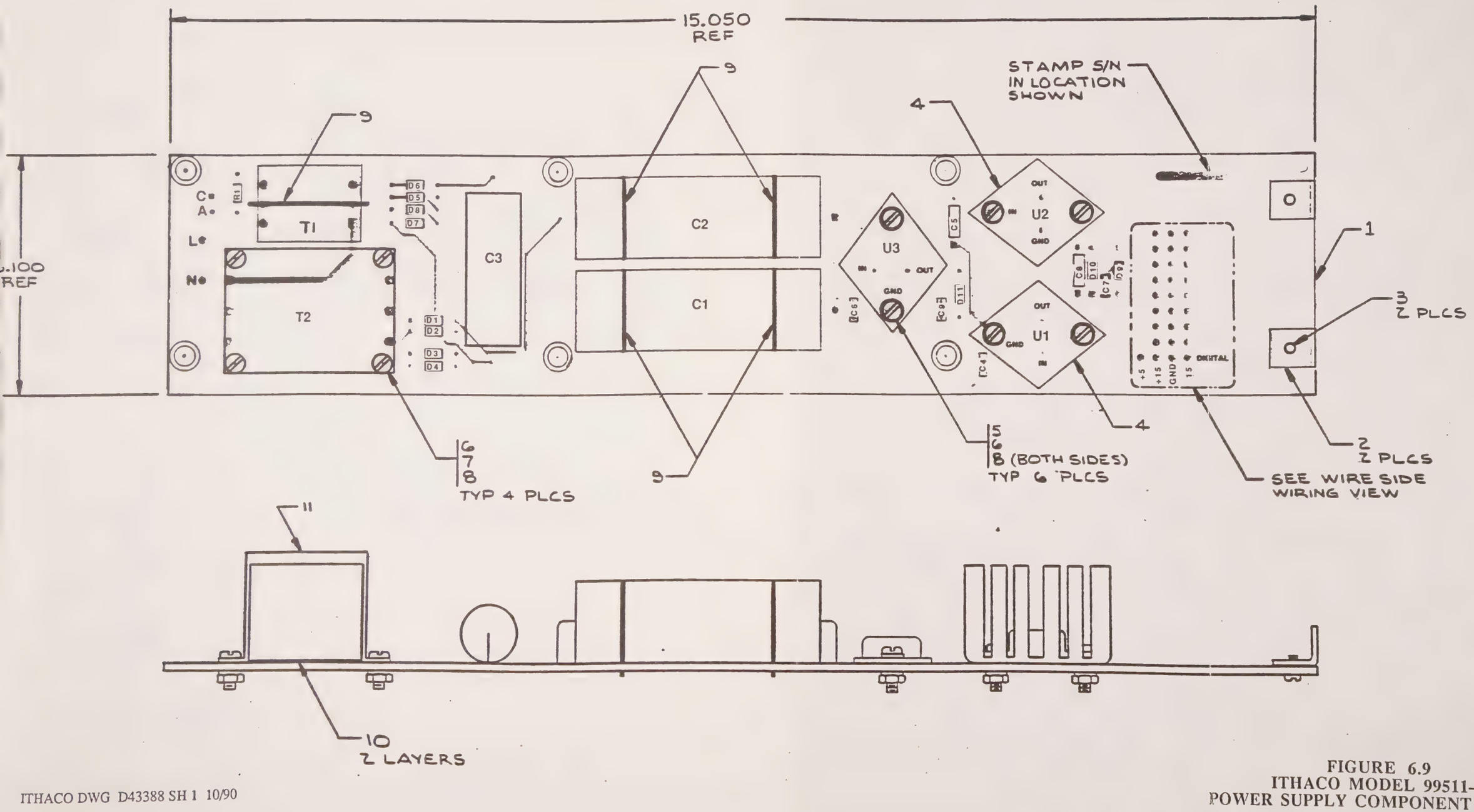




NOTES:
UNLESS OTHERWISE SPECIFIED
CAPACITOR VALUES ARE IN MICROFARADS
DIODES ARE 1N4148
RESISTOR VALUES ARE IN OHMS
RESISTORS ARE 1/4W, 5%

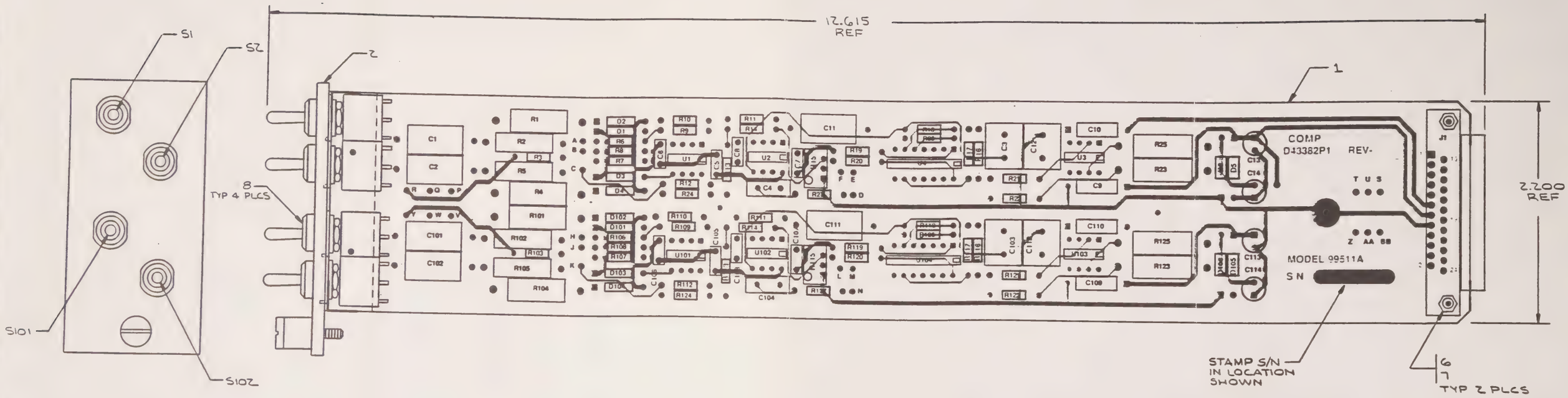
ITHACO DWG C33321 10/90

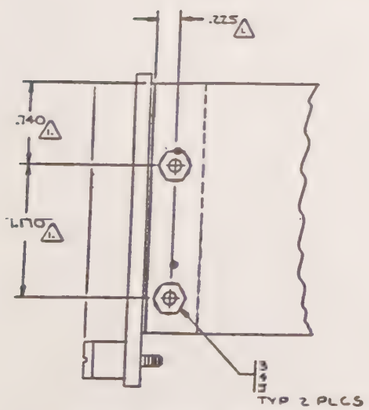
FIGURE 6.8
ITHACO MODEL 99511–B
QUAD CHANNEL DIGITAL AMPLIFIER
SCHEMATIC



ITHACO DWG D43388 SH 1 10/90

FIGURE 6.9
ITHACO MODEL 99511-C
POWER SUPPLY COMPONENT LAYOUT





MODIFICATION (SEE NOTE 1)
SCALE: NONE

TYPICAL WIRING VIEW
S1, S2, S101, S102

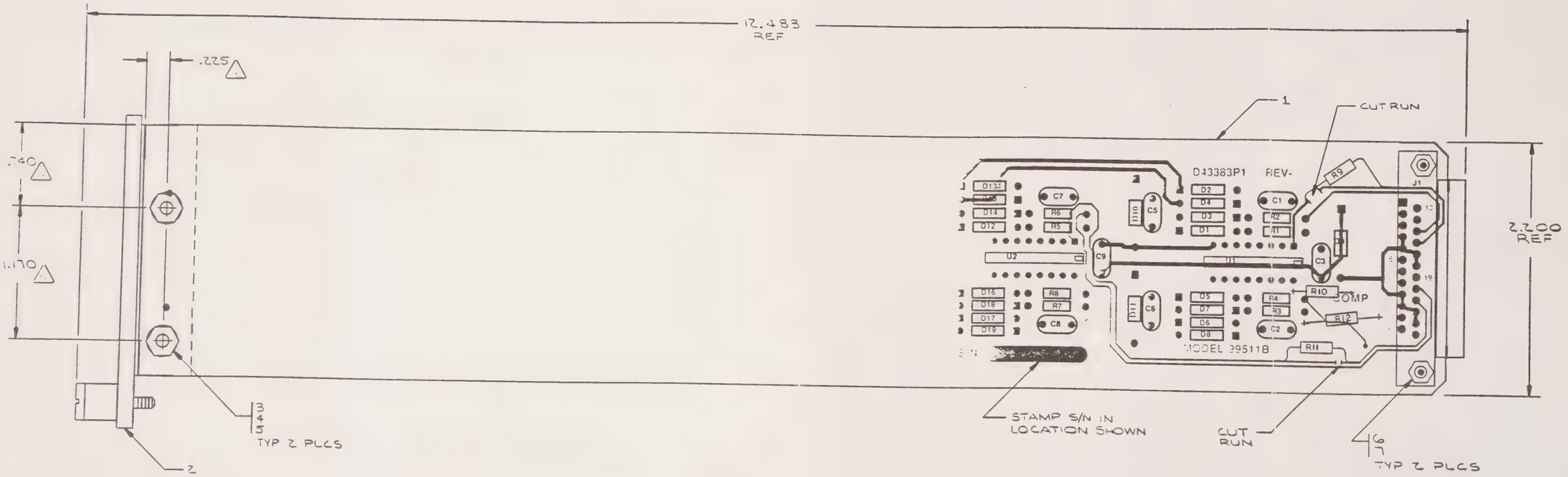
(G1) ASSEMBLY

NOTES:

1. PRIOR TO ASSEMBLY, DRILL TWO .128(#30) DIA HOLES PER DIMENSIONS GIVEN. DIMENSIONS ARE FROM CARD EDGE.
2. C113, C114, D105, D106 ARE NOT INSTALLED.

ITHACO DWG D43382 SH 1 10/90

FIGURE 6.10
ITHACO MODEL 99511–A
ANALOG AMPLIFIER COMPONENT LAYOUT



ITHACO DWG D43383 SH 1 10/90

FIGURE 6.11
ITHACO MODEL 99511–B
DIGITAL AMPLIFIER COMPONENT LAYOUT

SECTION 7

PARTS LIST

99511A	DUAL ANALOG AMPLIFIER	D43382 P/L
99511B	QUAD DIGITAL AMPLIFIER	D43383 P/L
99511C	POWER SUPPLY BOARD	D43388 P/L
99511C	CHASSIS COMPONENTS	D43401 P/L

NOTES:
PC = polycarbonate
SM = silver mica
CER = ceramic
TA = Tantalum electrolytic
AL = aluminum electrolytic
20T = twenty turn

ITHACO INC ITHACA NY

PARTS LIST FOR	TITLE	JOB NO
D43382 G1 SHT 2 OF 3	ASSY, NADC AMPLIFIER MODEL 99511A	
	FIRST MADE FOR 66950	LOT SIZE

ITEM	IDENT NUMBER	DESCRIPTION OR NAME	UNIT QTY	JOB QTY	PURCH ORDER	UNIT COST	TOTAL
C1,2,101, 102	811540053	CAP .01UF, 400V, 1% PC	4				
C3,103	811581012	330PF, 500V, 1% SM	2				
C4,104	811581008	100PF, 500V, 5% SM	2				
C5,6,7,8, 105,106, 107,108	811570036	0.1UF, 100V, 20% CER	8				
C9,10,109, 110	811501195	1.0UF, 35V, 10% TA	4				
C11, 111	811540042	0.1UF, 100V, 1% PC	2				
C12,112		TRIM SM	0				
C13,14	811504020	CAP 15UF, 20V, 10% TA	2				
D1,2,3,4, 101,102, 103,104	A86003	DIODE Low Leakage IN3595 INA @25°C & 125Vdc	8				
D5,6	818100007	DIODE 1N4005	2				
J1	812121034	CONNECTOR 24 POS AIRBORN WTB-24-PR7-SY (0.109 PIN)	1				
R1,4,101, 104	817032242	RES 2.4K, 1W, 5%	4				
R2,5,102, 105	817200114	33M, 1/2W, 1% IRC TYPE CGH	4				
R3,103	817000007	68M, 1/4W, 5%	2				
R6 THRU 14	A86215 P1	3.48K, 1/8W, 0.1%	1 SET OF 9				
R106 THRU 114	A86215 P1	RES 3.48K, 1/8W, 0.1%	1 SET OF 9				

DISTR	SYM	REVISIONS

MADE BY J Kotnel 9-18-90 ISSUED

APPROVALS WLT

PARTS LIST FOR D43382 G1 SHT 2 OF 3

PARTS LIST FOR	TITLE	JOB NO
D43382 G1 SHT 3 OF 3	ASM, NADC AMPLIFIER MODEL 99511A	LOT SIZE
	FIRST MADE FOR 66950	

ITEM	IDENT NUMBER	DESCRIPTION OR NAME	UNIT QTY	JOB QTY	PURCH ORDER	UNIT COST	TOTAL
R15,115	817801121	RESISTOR (POT) 500Ω, 20T,10%	2				
		BECKMAN 68WR					
R16,116	817212732	73.2K, 1/8W, 1%	2				
R17,117	817212137	13.7K, 1/8W, 1%	2				
R18,118	817211453	4.53K, 1/8W, 1%	2				
R19,20,119 120	817007105	1M, 1/4W, 5%	4				
R21,121	817007470	47Ω, 1/4W, 5%	2				
R22,122	817007202	2K, 1/4W, 5%	2				
R23,25,123, 125	817200115	49.9Ω, 1W, 1%	4				
R24,124	817210249	249Ω, 1/8W, 1%	2				
R26,126	817213316	316K, 1/8W, 1%	2				
R27,127		RESISTOR TRIM 1/8W, 1%	0				
S1,2,101, 102	815111012	SWITCH C & K 7211	4				
U1,2,101 102	816400168	OP AMP OP2107AP	4				
		BURR BROWN					
U3,103	816400169	BUFFER ELANTEK EL2001CN	2				
U4, 104	816400170	DUAL ANALOG SW DG200ABK	2				
		MAXIM					
1	D43382 P1	PRINTED WIRING BOARD	1				
2	C33316 P1	FRONT PANEL/ANGLE BRACKET	1				
3	812813408	SCR, FLAT HD, #4-40 x 1/4 LG	2				
4	812841114	L'WASHER, #4	2				
5	812831114	NUT, HEX #4	2				
6	812811410	SCR, PAN HD, #4-40 x 5/16 LG	2				
7	812830010	NUT, SMALL HEX, #4	2				
8	815110003	DRESS NUT, 1/4-20	4				

DISTR	SYM	REVISIONS

MADE BY	APPROVALS	PARTS LIST FOR
JKotmel 9-18-90		D43382 G1
ISSUED	WLT	SHT 3 OF 3

ITHACO INC ITHACA NY

PARTS LIST FOR	TITLE	JOB NO
D43383 G1 SHT 1 OF 1	ASSY, PWB QUAD DIGITAL AMPLIFIER MODEL 99511-B	
	FIRST MADE FOR 66950	LOT SIZE

ITEM	IDENT NUMBER	DESCRIPTION OR NAME	UNIT QTY	JOB QTY	PURCH ORDER	UNIT COST	TOTAL
C1,2,7,8	811572011	CAP 100PF, 1000V, 20% CER	4				
C3,5,6,9	811570036	CAP 0.1UF, 100V, 20% CER	4				
D1,2,3,4,5 6,7,8,12, 13,14,15, 16,17,18, 19	818100003	DIODE 1N4148	16				
D9,10,11	818100007	DIODE 1N4005	3				
J1	812121034	CONNECTOR 24 POS	1				
		AIRBORNE WTB-24-PR7-SY(REVERSED KEYED)		(0.109 PIN)			
R1,2,3,4,5 6,7,8	817007471	RESISTOR 470Ω, 1/4W, 5%	8				
R9,10,11,12	817007470	RESISTOR 47Ω, 1/4W, 5%	4				
U1,2	816300203	DUAL DIFF LINE RECVR UA9615DM	2				
		FAIRCHILD JM 38510/10404/BCB					
1	D43383 P1	PWB	1				
2	C33325 P1	FRONT PANEL/ANGLE BRACKET	1				
3	812813408	SCR, FLAT HD #4-40 x 1/4 LG	2				
4	812841114	L'WASHER, #4	2				
5	812831114	NUT, HEX #4	2				
6	812811410	SCR, PAN HD #4-40 x 5/16 LG	2				
7	812830010	NUT, SMALL HEX, #4	2				

DISTR	SYM	REVISIONS
A1		

MADE BY	APPROVALS	PARTS LIST FOR
J Kotsmel 9-18-90	WGT	D43383 G1
ISSUED		SHT 1 OF 1

ITHACO INC ITHACA NY

PARTS LIST FOR	TITLE	JOB NO
D43388 G1 SHT 1 OF 1	ASSY, PWB POWER SUPPLY MODEL 99511-C FIRST MADE FOR 66950	LOT SIZE

ITEM	IDENT NUMBER	DESCRIPTION OR NAME	UNIT QTY	JOB QTY	PURCH ORDER	UNIT COST	TOTAL
C1,2	811530018	CAP 1900UF, 50V, -10+75% AL	2				
		SPRAGUE 4201 39D 8947L					
C3	811530021	1000UF, 25V, -10+75% AL	1				
		CDE WBK 1000-25					
C4,6	811570017	0.22UF, 50V, 20% CER	2				
C5	811501199	2.2UF, 35V, 10% TA	1				
C7,9	811570036	0.1UF, 100V, 20% CER	2				
C8	811501195	CAP 1UF, 35V, 10% TA	1				
D1 THRU D11	818100007	DIODE 1N4005	11				
R1	817007681	RESISTOR 680Ω, 1/4W, 5%	1				
T1	815600022	TRANSFORMER PC16-55	1				
		SIGNAL CORP					
T2	815600023	TRANSFORMER PC34-700	1				
		SIGNAL CORP					
U1	816400165	VOLT REG LM140AK-15 (+15)	1				
		NATIONAL SEMICONDUCTOR					
U2	816400166	VOLT REG LM120AK-15 (-15)	1				
		NATIONAL SEMICONDUCTOR					
U3	816400167	VOLT REG LM140AK-5 (+5)	1				
		NATIONAL SEMICONDUCTOR					
1	D43388 P1	PWB	1				
2	A11054 G1	ANGLE BRACKET	2				
3	812811407	SCREW, #4-40 x 7/32 LG	2				
4	812800220	HEATSINK THERMALLOY 6016B	2				
5	812811616	SCREW, #6-32 x 1/2 LG	6				
6	812831116	NUT, HEX, #6-32	10				
7	812811612	SCREW, #6-32 x 3/8 LG	4				
8	812841116	L'WASHER #6	16				
9	816099500	LACING CORD	AR				
10	813100067	KAPTON TAPE, 1" WIDE	AR				
11	815600024	MOUNTING BRACKET SIGNAL CORP 24BR	1				

DISTR	SYM	REVISIONS
A1		

MADE BY	APPROVALS	PARTS LIST FOR
J Kotimel 9-18-90		D43388 G1
ISSUED	WHT	SHT 1 OF 1

MODEL 99511C REPLACEABLE CHASSIS PARTS

ITEM	QTY	IDENT #	DESCRIPTION
1	8	812121035	24 PIN SOCKET RECEPTACLE, NORMALLY KEYED. AIRBORNE WTB–24–SEC–SY
2	1	812121035	24 PIN SOCKET RECEPTACLE, REVERSE KEYED. AIRBORNE WTB–24–SEC–SY
3	1		NUT SPANNER WRENCH FOR REMOVING/ INSTALLING KEYED GUIDES, ITEMS 1 & 2. AIRBORNE TN4612
4	1	812101017	37 PIN PANEL MOUNT CONNECTOR M81511/01ED01P1. AMPHENOL 348–40E14–37P1
5	1	812101018	85 PIN PANEL MOUNT CONNECTOR M81511/01EF01P1 AMPHENOL 348–40E18–85P1
6	1	815111032	POWER SWITCH, SPDT ARROW/HART A5636A
7	1	818149006	LIGHT EMITTING DIODE, RED DIALCO 521–9165
8	1	812500034	LED HOLDING CLIP DIALIGHT 515–0005
9	1	812120015	AC INPUT MODULE WITH FUSE, PANEL COMPONENTS, INC. 831 101 10
10	20	812130125	INSULATED BNC CONNECTOR, AMP INC 227726–2
11	2	815183031	FUSE 5x20mm 1/2A SLO–BLO 250V. LITTLEFUSE 218.500
12	1	816000101	LINE POWER CORD, 7 1/2 FT. BELDEN 17250–5PH–386
13	2		SCREW FOR TOP/BOTTOM COVER CENTER ATTACHMENT. #6–32 x 3/8 SLOTTED FLATHEAD
14	4		SCREW FOR TOP/BOTTOM COVER REAR ATTACHMENT HOLES. #6–32 X 1/4 PHILLIPS PAN HEAD WITH INTEGRAL LOCKWASHER. BUCKEYE 6BHP–1143

APPENDIX A

ITHACO MODEL 99511

TEST OF LOW FREQUENCY ROLLOFF CALIBRATION PER 5.3.2.4

Derivation of Test Limits

1. The 5 Hz low frequency rolloff calibration is not easy to measure directly at 5 Hz due to the poor accuracy and stability of many test instruments at this frequency. Therefore test step 5.3.2.4 measures the low frequency cutoff indirectly making a measurement at 20 Hz to see if the phase shift at 20 Hz corresponds to a correct –3 dB rolloff at 5 Hz.

2. There are actually two rolloffs to consider: the .5 Hz input coupling frequency (fc_1) and 5 Hz midstage coupling frequency (f_{c2}).

$$f_{c1} = 1/(2\pi R_2 C_1) = 1/(2\pi\ .01\mu F\ 33M)$$
$$f_{c1} = .482\ Hz$$

$$f_{c2} = 1/(2\pi R_{26} C_{11}) = 1/(2\pi\ .1\mu F\ 316K)$$
$$f_{c2} = 5.037\ Hz$$

3. At 5 Hz the expected gain due to these two single–pole highpass functions is given by:

$$G_1 = 1/\sqrt{1 + (f_{c1}/f)^2}$$

$$G_1 = 1/\sqrt{1 + (.482/5)^2} = .9954$$

$$dB_1 = 20 \log_{10}(G_1) = -.04\ dB$$

$$G_2 = 1/\sqrt{1 + (f_{c2}/f)^2}$$

$$G_2 = 1/\sqrt{1 + (5.037/5)^2} = .7058$$

$$dB_2 = 20 \log_{10} = -3.03\ dB$$

Thus the expected attenuation at 5 Hz is given by: $dB\ (total) = dB_1 + dB_2 = -3.07\ dB$

Allowing for ±5% cutoff tolerance in fc2 and calculating the expected attenuation at 5 Hz as above we arrive at:

$$dB\ (max) = -3.00\ dB\ @\ f_{c2} = 1.05 \times 5.037 = 5.29\ Hz$$
$$dB\ (min) = -3.19\ dB\ @\ f_{c2} = .95 \times 5.037 = 4.80\ Hz$$

4. At 5 Hz the expected phase is given by:

$$\emptyset_1 = \arctan(f_{c1}/f) = \arctan(.182/5) = +5.50°$$

$$\emptyset_2 = \arctan(f_{c2}/f) = \arctan(5.037/5) = +45.21°$$

$$\emptyset(total) = \emptyset_1 + \emptyset_2 = +50.71°$$

Allowing for a ±5% cutoff tolerance in f_{c1} and in f_{c2} and calculating the expected phase shift at 5 Hz as above we arrive at:

$$\begin{aligned} \text{Ø (max)} &= \arctan(.482 \times 1.05/5) \\ &+ \arctan(5.037 \times 1.05/5) \\ &= 5.88^\circ + 46.61^\circ = +52.49^\circ \end{aligned}$$

$$\begin{aligned} \text{Ø (min)} &= \arctan(.482/1.05/5) \\ &+ \arctan(5.037/1.05/5) \\ &= 5.25 + 43.81 = 49.06^\circ \end{aligned}$$

5. Thus at 5 Hz we expect to see:

$$-3.10 \text{ dB} \pm 0.10 \text{ dB} \ @ \ +50.78^\circ \pm 1.72^\circ$$

6. When we move to a 20 Hz test frequency we could look at either amplitude or phase as a function of cutoff error. We choose phase because it is easier to measure accurately and is a stronger function of error.

$$\begin{aligned} \text{Ømax} &= \arctan(.482 \times 1.05/20) \\ &+ \arctan(5.037 \times 1.05/20) \\ &= 1.44^\circ + 14.81^\circ = 16.25^\circ \end{aligned}$$

$$\begin{aligned} \text{Ømin} &= \arctan(.482/1.05/20) \\ &+ \arctan(5.037/1.05/20) \\ &= 1.31^\circ + 13.48^\circ = 14.79^\circ \end{aligned}$$

7. Thus at 20 Hz we expect to see a phase angle of:

$$+15.52^\circ \pm 0.73^\circ$$

if our cutoff frequency is within specification ±5%.

8. Since 16.25° corresponds to 5.037 x 1.05 = 5.29 Hz LF cutoff and 14.79° corresponds to 5.037/1.05 = 4.80 Hz LF cutoff, we have a linear approximation of cutoff as a function of phase observation given by:

$$\begin{aligned} f_c &= m\text{Ø} + b \\ 5.29 &= m(16.25) + b \quad \text{(i)} \\ 4.80 &= m(14.79) + b \quad \text{(ii)} \end{aligned}$$

subtracting (ii) from (i):

$$.49 = m(1.46) \quad \text{or} \quad m = .336$$

substituting m into (i) or (ii) gives b = –.17, therefore

$$f_c = .336\text{Ø} - .17$$

This equation allows us to calculate the actual cutoff frequency from the observed phase shift at 20 Hz.

WARRANTY

ITHACO, Inc. warrants each instrument to be free of defects in material and workmanship for a period of one year, unless otherwise specified, after shipment to the original purchaser; batteries are specifically excluded. Liability under this warranty is limited to repairing or adjusting any instrument returned to the factory for that purpose. The warranty of this instrument is void if the instrument has been modified other than in accordance with written instructions from ITHACO, or if defect or failure is judged by ITHACO to be caused by abnormal conditions of operation, storage or transportation.

This warranty is subject to verification by ITHACO, that a defect or failure exists, and to compliance by the original purchaser with the following instructions:

1. Before returning the instrument, notify ITHACO with full details of the problem; including the model number and serial number of the instrument involved.

2. After receiving the above information, ITHACO will give you shipping instructions or service instructions. After receipt of the shipping instructions, ship the instrument to ITHACO. Full liability for damage during shipment is borne by the purchaser. It is recommended that instruments shipped to us be fully insured and packed surrounded by at least 2 inches of shock–absorbing material.

ITHACO reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This warranty is expressly in lieu of all other obligations or liabilities on the part of ITHACO, and ITHACO neither assumes, nor authorizes any other person to assume for it, any liability in connection with the sale of ITHACO instruments.

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